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NPG Report No. 1449

90 023

**FC**

HIGH VELOCITY IMPACTS OF  
250 LB. G. P. BOMB MK 81



**U. S. NAVAL PROVING GROUND  
DAHLGREN, VIRGINIA**

APR 1 3 1956

56

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U. S. Naval Proving Ground  
Dahlgren, Virginia

High Velocity Impacts of  
250 lb. G. P. Bomb Mk 81  
by

F. W. Kasdorf  
Terminal Ballistics Department

NPG REPORT NO. 1449

Task Assignment No.  
NPG-S3-3d-442-1-56

29 March 1956

APPROVED: J. F. BYRNE  
Captain, USN  
Commander, Naval Proving Ground

  
R. D. RISSE  
Captain, USN  
Ordnance Officer  
By direction

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ABSTRACT

The air-to-ground, rocket propelled, optically guided missile Bullpup is now under development by the Glenn L. Martin Company for the Bureau of Aeronautics. The existing 250 lb. G. P. bombs Mk 81 and AN-M-57A1, as well as the 220 lb. M81 fragmentation bomb, are all being considered as possible warheads for this missile. Inasmuch as its impact velocity is expected to fall in the range of 1100 to 1900 ft./sec. the question has arisen as to whether the bomb's ability to penetrate targets in effective bursting conditions will be seriously impaired by the high striking velocities. This information is of particular importance since a fuze delay would be tactically desirable, and a delay fuze is useless if the bomb does not remain intact after penetrating its target. Normally these bombs are not tested at impact velocities greater than 1000 ft./sec., since this is the maximum velocity that would be expected from a free fall. Therefore, a limited program has been conducted on the 250 lb. G. P. Mk 81 bomb to find the effect of higher striking velocities on bomb break-up.

The results indicate that the inert loaded 250 lb. G. P. bomb Mk 81:

a. Will penetrate 7/8" STS armor plate at 20° obliquity at 1470 ft./sec. but will break up in penetrating this target at 1735 ft./sec. or higher velocities.

b. Will penetrate sand or normal earth (free of rocks, stones, etc.) and remain in effective condition at 1700 ft./sec. and 20° obliquity but will break up at 1900 ft./sec.

FOREWORD

This is the final report on high velocity impact tests of the 250 lb. G. P. Mk 81 Low Drag Bomb, which is being considered for use as a warhead for the Bullpup missile. The program was conducted under Task Assignment NPG-S3-3d-442-1-56 as authorized by reference (a). The bombs were received under reference (b), tested during the period 14 December 1955 to 3 January 1956, and a preliminary report submitted as reference (c).

Lieutenant (jg) G. J. Miskho of the Terminal Ballistics Department conducted the firings.

This report was reviewed by:

C. B. GREEN, Director of Terminal Ballistics Research  
J. R. WELSH, Commander, USN  
Terminal Ballistics Officer  
R. H. LYDDANE, Director of Research

INTRODUCTION

The air-to-ground, rocket propelled, optically guided missile Bullpup is now under development by the Glenn L. Martin Company for the Bureau of Aeronautics. The existing 250 lb. G. P. bombs Mk 81 and AN-M57A1, as well as the 220 lb. M81 fragmentation bomb, are all being considered as possible warheads for this missile. Inasmuch as its impact velocity is expected to fall in the range of 1100 to 1900 ft./sec. the question has arisen as to whether the bomb's ability to penetrate targets in effective bursting condition will be seriously impaired by the high striking velocities. This information is of particular importance since it would be desirable to use a delay fuze with the G. P. bombs. Such a fuze is useless if the bomb does not remain intact after penetrating its target. Normally these bombs are not tested at impact velocities greater than 1000 ft./sec. since this is the maximum velocity that would be expected from a free fall. Therefore, a limited program has been conducted on the 250 lb. G. P. Mk 81 bomb to obtain preliminary data on the effect of higher striking velocities on bomb break-up.

DESCRIPTION OF MATERIAL

Five 250 lb. G. P. Mk 81 bombs were inert loaded with a perlite-cement-water mixture to a weight of  $250 \pm 10$  lbs. The flat-faced nose fuze being developed by the Elgin National Watch Company for use in the missile warhead, was simulated by 4" diameter flat base plugs, removed from other 250 lb. bombs, inserted in the nose of these bombs. The fuze wells were left empty.

DESCRIPTION OF TEST EQUIPMENT

The following equipment and materials were used in conducting this program:

- a. Gun: 9812/31.5 Smoothbore Gun No. 1

- b. Propellant: NPFR-241(6" /4") powder  
56.0# for 1470 ft./sec.  
67.0# for 1710 ft./sec.  
78.0# for 1920 ft./sec.  
with bomb rammed 74% from breech end
- c. Targets: Sand and 7/8" STS armor plate
- d. Velocity Measurements: Solenoid coils and oscilloscope
- e. Cameras: 35mm Fastax, Speed Graphic

#### PROCEDURE

Since the major diameter of the Mk 81 bomb is 9"0 and the gun employed was a 9"1 diameter smoothbore, it was unnecessary to provide any forward bourrelet on the bomb. A 1-5/8" thick x 9"097 diameter steel base plate was attached to the base of the bomb by means of four set screws which engaged in the V-notch at the base of the bomb. This design permitted the base plate to tear loose from the bomb upon plate impact without damaging the base of the bomb. Only one inert Bullpup fuze was available, Figure (2), so bomb base plugs (the most readily available item with the proper thread) were used to simulate the fuzes. The Mk 81 bomb had consistently penetrated 7/8" STS plate and 1" S plate a large percentage of the time at 1000 ft./sec., in effective condition. Therefore, 7/8" STS at 20° oblique was chosen as the initial high velocity (1900 ft./sec.) target. Earth or sand are also conceived of as being possible impact materials for this missile so the break velocity was determined for sand. A 3/4" thickness plywood faced the front of the sand pile with the wood piled up in contact with the wood.

A 16mm Fastax camera, operated at 2500 frames/sec., was used on round 2 to photograph the bomb between the gun muzzle and target and provide information on the gun stability. A Ballistic Synchrocamera was used to photograph round 3 to obtain more detailed information on the base plate, simulated nose fuze and altitude on the base of the bomb immediately before impact.

Velocities were measured in the conventional manner by solenoids and oscilloscopes.

#### RESULTS AND DISCUSSION

Table 1, Appendix (A), gives the test conditions and results for the five bombs fired in this program. These data are supplemented by butt impact records of each round (Appendix (B)) and photographs of the recovered bombs (Appendix (C)).

The results are summarized as follows:

<u>Target*</u>	<u>Velocity ft./sec.</u>	<u>Condition of Recovered Bomb</u>
7/8" STS	1919	Broken up
	1735	Broken up
	1470	Effective-intact, deformed
	1933	Broken up
Sand	1704	Effective-intact, good condition

\*One impact at each condition. All impacts at 20° obliquity.

#### Round 1

The first round was fired at the highest impact velocity this missile is expected to attain, 1919 ft./sec. The velocity of the launching aircraft would be at least 500 knots, it would have a steep dive angle and release the missile somewhere below 15,000 ft., reference (d), to enable the missile to reach such a striking velocity. The 7/8" STS target, which might represent some armored type of vessel, was perforated by the bomb but served to break it up into numerous pieces, thus preventing the operation of any delay fuze and destroying the effectiveness of the missile, Figure (3).

#### Round 2

The least severe target material available, sand, was utilized for the next round in order to determine whether the bomb could withstand any type of impact at this high a velocity. The forward section of the bomb had broken into

numerous pieces but the base section had held together, Figure (4). This indicated that at some slightly lower velocity the bomb might hold together in penetrating sand or earth. High speed photography of the round from the gun muzzle to the target indicated that the bomb was flighting well and was intact upon impacting the target, Figure (5).

#### Round 3

Inasmuch as this missile might be fired into earth or sand at such an angle that it would detonate below a surface structure, it was deemed advisable to continue with the investigation of sand targets at a lower impact velocity. At a 500 knot launching speed and 70° dive angle, the missile would have an impact velocity of 1700 ft./sec. when released between 15,000 and 20,000 ft. altitude. Therefore round 3 was impacted against sand at 1700 ft./sec. and 20° obliquity to simulate these conditions. Under these conditions the bomb remained in good condition after penetrating a sand target fronted by 3/4" plywood, Figure (6). The nose plug was pushed in as a result of the impact. A ballistic synchrocamera picture of the round just before target impact indicated that the round was intact and in stable flight condition, Figure (7) (the bomb is shortened in this picture because the film speed was too high).

#### Round 4

Since 1700 ft./sec. is an impact velocity that might be anticipated under numerous high speed launching conditions, it was used against another 7/8" STS target. The bomb was again found to be broken up after penetrating the armor plate target at 20° obliquity but not as badly as it had been at the 1919 ft./sec. striking velocity. The forward part of the bomb was split open but the base had held together, Figure (8).

#### Round 5

This round was fired to obtain a penetration velocity limit on the 7/8" STS target at 20° obliquity. The condition of the previous round had indicated that this limit might be in the neighborhood of 1500 ft./sec. At an actual impact velocity of 1470 ft./sec the bomb penetrated

the target and remained intact, although deformed in the nose section. It is conceivable that the deformation would have been sufficient to prevent a nose fuze from functioning or cause a nose booster charge to deflagrate, Figure (9). This is an impact velocity that in all probability would be obtained with a launching speed lower than 500 knots; more likely at 250 knots.

#### CONCLUSIONS

It is concluded that the inert loaded 250 lb. G. P. Bomb Mk 81:

- a. Will penetrate 7/8" STS armor plate at 20° obliquity at 1470 ft./sec. but will break up in penetrating this target at 1735 ft./sec. or higher velocities.
- b. Will penetrate sand or normal earth (free of rocks, stones, etc.) and remain in effective condition at 1700 ft./sec. and 20° obliquity but will break up at 1900 ft./sec.

#### REFERENCES

- (a) BUORD Conf ltr Re3d-ANB:bjk Ser 11691 of 15 Nov 1955
- (b) AM30 565542
- (c) NPG Conf Preliminary Report 25 Jan 1956
- (d) Glenn L. Martin Company Conf Report ER 6460 -- Model XASM-N-7 Guided Missile Weapon System

**APPENDIX A**

CONFIDENTIAL

NPG REPORT NO. 1449

TABLE IFIRING CONDITIONS AND RESULTS

<u>Bomb</u>	<u>Target</u>	<u>Strik.</u>	<u>Through</u>	<u>Remarks</u>					
<u>Date</u>	<u>Material</u>	<u>Vel.</u>	<u>Opening</u>						
<u>Fired</u>	<u>No.</u>	<u>ft. / sec.</u>	<u>ft.</u>						
1955 12/14	Impact 43470	Rd. 1	Bomb Wt. 243	Target Conditions 7/8" STS	Oblique 20°	1919	Comp.	9-1/2"x10-1/2"	Ineffective-Bomb shattered.
1955 12/16	Impact 43477	Rd. 2	Bomb Wt. 240	Target Conditions Sand	Oblique 20°	1933	Comp.	—	Ineffective-for- ward section of bomb broke up, base held together.
1956 12/20	Impact 43490	Rd. 3	Bomb Wt. 245	Target Conditions Sand	Oblique 20°	1704	Comp.	—	Effective-intact, bomb in good condition.
1956 12/22	Impact 43493	Rd. 4	Bomb Wt. 240	Target Conditions STS	Oblique 20°	1735	Comp.	10-1/2"x12"	Ineffective-for- ward section split open, base held together.
1956 1/3	Impact 43514	Rd. 5	Bomb Wt. 240	Target Conditions STS	Oblique 20°	1470	Comp.	10"x12"	Effective-intact, except for deformation of nose section.

Note: Bombs fired from 9"x12/31.5 Smoothbore Gun No. 1

**APPENDIX B**

## BUTT IMPACT RECORD

U. S. NAVAL PROVING GROUND  
DAHLGREN, VA.

REF ID: A1

TEST OBJECT	IMPACT NUMBER <b>43470</b>
TEST OBJECT	DATE OF IMPACT <b>12-14-55</b>
TEST OBJECT	BUTT NO <b>R</b>

PLATE		BOMB PROJECTILE	
GAUGE	CLASS	CALIBER	TYPE
.375	PCS	.350 I.B. G. P.	Low Drag
MANUFACTURE	CONTRACT	MANUFACTURER	LOT NO
Lukens	N600-155S-30292	A. D. Smith	2
GROUP	NO	MARK	MOO
	65	81	1
DIMENSIONS	90" x 300"	PROJECTILE NO	YEAR OF SPECIFICATION
		1	-- --
IMPACT DATA		CAPPED	LENGTH (Uncapped)
OBLIQUITY	PENETRATION	<input type="checkbox"/> YES <input checked="" type="checkbox"/> NO	-- --
20°	Comp.		WEIGHT (Capped)
THICKNESS AT IMPACT	NO. OF IMPACT ON PLATE		WEIGHT (Uncapped)
.87"	1		243.00
DISTANCE FROM NEAREST IMPACT	THROUGH OPENING	FUZE NOSE - Flat	FILLER
55"	9-1/2" x 10-1/2"	base plate in use	Perlite-Cement-Water
DISTANCE FROM	DISTANCE FROM	CONDITION AFTER FIRING	
TOP <input type="checkbox"/> BOTTOM <input checked="" type="checkbox"/> 56"	RIGHT <input type="checkbox"/> LEFT <input checked="" type="checkbox"/> 145"	<input type="checkbox"/> EFFECTIVE <input checked="" type="checkbox"/> INEFFECTIVE	
FLAKING FRONT	FLAKING BACK	Boat broke up; completely shattered	
0"	0"		
SPUR	DISH		
8"	2"		
CRACKS	BULGE		
0"	(1")		
BUTTON			
<input checked="" type="checkbox"/> THROWN <input type="checkbox"/> STARTED			
VELOCITY (F.S.)			
DESIRED	OBTAINED	<input type="checkbox"/> MUZZLE	<input type="checkbox"/> STRIKING <input checked="" type="checkbox"/> MEAN <b>1919</b>
REMARKS			

GUN: 90MM No. 30-A-500

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SIGNATURE	J. E. KING, JR., CHIEF OF STAFF, U.S.A.F.		
COMMISSIONED	FEBRUARY 1955		
FACSIMILE PRINT, WASH., D.C.			

## BUTT IMPACT RECORD

U. S. NAVAL PROVING GROUND  
DAHLGREN, VA.

REF. (a)

TEST OBJECT		IMPACT NUMBER <i>1000</i>
		DATE OF IMPACT <i>10/10/68</i>
		BUTT NO <i>1</i>
PLATE		SOIL PROJECTILE
Gauge	CLASS	CALIBER <i>106 MM. B.C. 12 P.</i>
MANUFACTURER	CONTRACT	TYPE <i>LEAD JACKET</i>
GROUP	NU	MANUFACTURER <i>A. O. FISHER</i>
DIMENSIONS		LOT NO <i>2</i>
IMPACT DATA		MATERIAL <i>SOIL</i>
OBLIQUITY	PENETRATION	MARK <i>2</i>
THICKNESS AT IMPACT	NO. OF IMPACT ON PLATE	PROJECTILE NO <i>106-1000-1000</i>
DISTANCE FROM NEAREST IMPACT	THROUGH OPENING	YEAR OF SPECIFICATION <i>1968</i>
DISTANCE FROM <input type="checkbox"/> TOP <input type="checkbox"/> BOTTOM	DISTANCE FROM <input type="checkbox"/> RIGHT <input type="checkbox"/> LEFT	CAPPED <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO
FLAKING FRONT	FLAKING BACK	LENGTH (Uncapped) <i>106 mm.</i>
SPUR	DISH	WEIGHT (Capped) <i>106 gm.</i>
CRACKS	BULGE	FUZE <i>106 mm. - 1000</i>
BUTTON <input type="checkbox"/> THROWN <input type="checkbox"/> STARTED		FILLER <i>Lead jacket - Copper jacket - Cement - Wax</i>
CONDITION AFTER FIRING <input type="checkbox"/> EFFECTIVE <input type="checkbox"/> INEFFECTIVE		
VELOCITY (F.S.)		
DESIRED	OBTAINED	<input type="checkbox"/> MUZZLE <input type="checkbox"/> STRIKING <input checked="" type="checkbox"/> MEAN
REMARKS		

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1000	106	1000
10/10/68	106 mm.	1000
1	106 mm.	1000
106 mm. - 1000		1000
106 mm. - 1000		

Navy Ordnance Test Station, Dahlgren, Virginia

BUTT IMPACT RECORD  
PROVING GROUNDU. S. NAVAL PROVING GROUND  
DAHlgREN, VA.

REF: (a)

TEST GUIDE

BUTT Impact at High Velocity

IMPACT NUMBER	43490
DATE OF IMPACT	12-20-55
BUTT NO	
P	

PLATE		BOMB		PROJECTILE	
GAUGE	CLASS	CALIBER	TYPE		
MANUFACTURER	CONTRACT	250 lb. G. P.	Low Drag		
GROUP	(NO PLATE) 3/4" PLYBOARD BACKED BY SAND	MANUFACTURER	LOT NO		
DIMENSIONS	NO	A. O. Smith	2		
3/4" PLYBOARD BACKED BY SAND		MARK	MOD		
		81	1		
IMPACT DATA		PROJECTILE NO	YEAR OF SPECIFICATION		
OBLIQUITY	PENETRATION	CAPPED	LENGTH (Uncapped)		
THICKNESS AT IMPACT	NO OF IMPACT ON PLATE	<input type="checkbox"/> YES <input checked="" type="checkbox"/> NO	—		
DISTANCE FROM NEAREST IMPACT	THROUGH OPENING	WEIGHT (Capped)	WEIGHT (Uncapped)		
DISTANCE FROM	DISTANCE FROM	—	245.00#		
<input type="checkbox"/> TOP <input type="checkbox"/> BOTTOM	<input type="checkbox"/> RIGHT <input type="checkbox"/> LEFT	FUZE	FILLER		
FLAKING FRONT	FLAKING BACK	None - flat base plate in nose	Perlite-Cement-Water		
SPUR	DISH	CONDITION AFTER FIRING			
CRACKS	BULGE	<input type="checkbox"/> EFFECTIVE <input checked="" type="checkbox"/> INEFFECTIVE			
BUTTON		Intact, bomb in good condition			
<input type="checkbox"/> THROWN <input type="checkbox"/> STARTED					
VELOCITY (F.S.)					
DESIRED	OBTAINED	<input type="checkbox"/> MIZZLE	<input type="checkbox"/> STRIKING	<input checked="" type="checkbox"/> MEAN	1704
REMARKS					

GUN: 9032 No. 1 Mk A Gun

		RECORD
		<input type="checkbox"/> A <input type="checkbox"/> B
SIGNATURE	G. J. WISKE	TEST OFFICER

BUTT IMPACT RECORD  
PRINC-NPC-314

**U. S. NAVAL PROVING GROUND  
DAHLGREN, VA.**

REF ID: C6111353

TEST OBJECT		IMPACT NUMBER <b>43493</b>	
Bomb Impacts at High Velocity		DATE OF IMPACT <b>12-22-55</b>	
		BUTT NO <b>3</b>	
PLATE		BOMB	PROJECTILE
GAUGE <b>.87"</b>	CLASS <b>STS</b>	CALIBER <b>250 lb. G. P.</b>	TYPE <b>Low Drag</b>
MANUFACTURER <b>Lukens</b>	CONTRACT <b>N600-1553-30292</b>	MANUFACTURER <b>A. O. Smith</b>	LOT NO <b>2</b>
GROUP <b>--</b>	NO <b>65</b>	MARK <b>81</b>	MOU <b>1</b>
DIMENSIONS <b>96" x 300"</b>		PROJECTILE NO <b>5</b>	YEAR OF SPECIFICATION <b>--</b>
IMPACT DATA		CAPPED <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO	LENGTH (Uncapped) <b>--</b>
OBLIQUITY <b>20°</b>	PENETRATION <b>Ccomp.</b>	WEIGHT (Capped) <b>--</b>	WEIGHT (Uncapped) <b>240.00 lbs</b>
THICKNESS AT IMPACT <b>.87"</b>	NO. OF IMPACT ON PLATE <b>--</b>	FUZE <b>None - flat base plate in nose</b>	FILLER <b>Perlite-Cement-Wate</b>
DISTANCE FROM NEAREST IMPACT <b>36"</b>	THROUGH OPENING <b>10-1/2" x 1.2"</b>	CONDITION AFTER FIRING <input type="checkbox"/> EFFECTIVE <input checked="" type="checkbox"/> INEFFECTIVE	
DISTANCE FROM <input checked="" type="checkbox"/> TOP <input type="checkbox"/> BOTTOM <b>66"</b>	DISTANCE FROM <input type="checkbox"/> RIGHT <input type="checkbox"/> LEFT <b>115"</b>	Forward section split open, base held together	
FLAKING FRONT <b>0"</b>	FLAKING BACK <b>0"</b>		
SPLIT <b>5"</b>	DISH <b>3"</b>		
CRACKS <b>0"</b>	BULGE <b>0"</b>		
<input checked="" type="checkbox"/> THROWN <input type="checkbox"/> STARTED			
Impact Dim. <b>11" x 12-1/2"</b>		VELOCITY (F.S.)	
DESIRED	OBTAINED	<input type="checkbox"/> MIZZLE	<input type="checkbox"/> STRIKING
		<input checked="" type="checkbox"/> MEAN <b>1735</b>	
REMARKS			

GUN: 2212 No. 1 Mk A Mod. v

SEARCHED	INDEXED	SERIALIZED	FILED
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G. J. RISKHO LTJG, USN, TEST OFFICER

**BUTT IMPACT RECORD**

U. S. NAVAL PROVING GROUND,  
DAHLGREN, VA.

REF: (a) ENCL: (b) (c) (d) (e) (f) (g) (h) (i) (j) (k) (l) (m) (n) (o) (p) (q) (r) (s) (t) (u) (v) (w) (x) (y) (z)

TEST OBJECT		IMPACT NUMBER 43514
Bomb Impact at High Velocity		DATE OF IMPACT 1-3-56
		BOTT NO 3
PLATE		TYPE XXXXXX
GAUGE .87"	CLASS STS	CALIBER 250 lb. G. P.
MANUFACTURER Lukong	CONTRACT N600-1558-30292	MANUFACTURER F. E. Crane
GROUP 40	65	DATA 81
DIMENSIONS 96" x 300"		PROJECTILE NO 1
IMPACT DATA		YEAR OF SPECIFICATION 1951
OBLIQUITY 20°	PENETRATION Comp.	CAPPED <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
THICKNESS AT IMPACT .87"	NO. OF IMPACT ON PLATE 3	WEIGHT (Capped) 239.50#
DISTANCE FROM NEAREST IMPACT 26"	THAYSON OPENING 10" x 12"	FUSE FILLER Perlite-Cement-Water
DISTANCE FROM <input checked="" type="checkbox"/> TOP <input type="checkbox"/> BOTTOM PENETRATING FRONT 0"	DISTANCE FROM <input type="checkbox"/> INRIGHT <input checked="" type="checkbox"/> LEFT 205"	CONDITION AFTER FIRING <input checked="" type="checkbox"/> EFFECTIVE <input type="checkbox"/> INEFFECTIVE
CRACKS 0"	FRAMING BACK 3"	Intact except for reformation of none section
WITNESS <input checked="" type="checkbox"/> THROB <input type="checkbox"/> STARTED		VLOCITY (F.S.)
DESIRED	ESTIMATED	<input type="checkbox"/> V.221 <input type="checkbox"/> STRENGTH <input checked="" type="checkbox"/> STAB 1470

GEN-8912-Nos. 1 RECALLED

10. The following table shows the number of hours worked by each employee.

Figure 1. The relationship between the number of species and the area of forest cover in each state.

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DEPARTMENT OF NATIONAL DEFENCE  
COMBINED CHIEF STAFF  
HEADQUARTERS  
Navy-Dredging  
WASH., D.C.

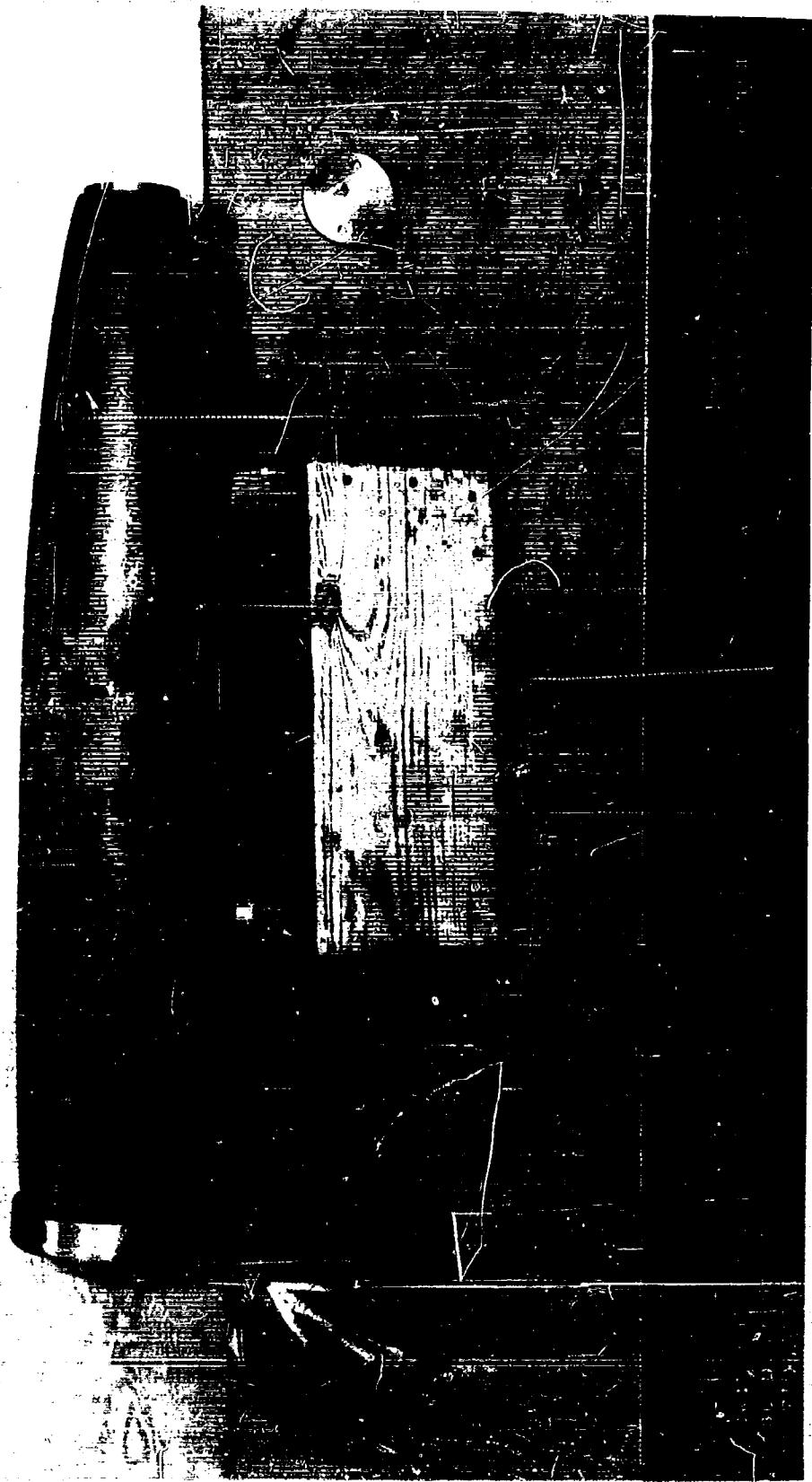
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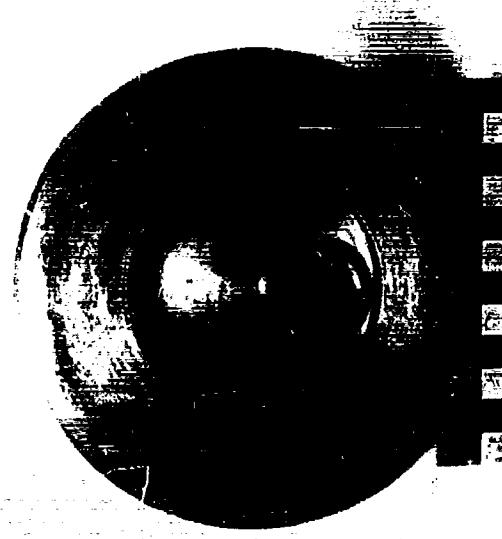
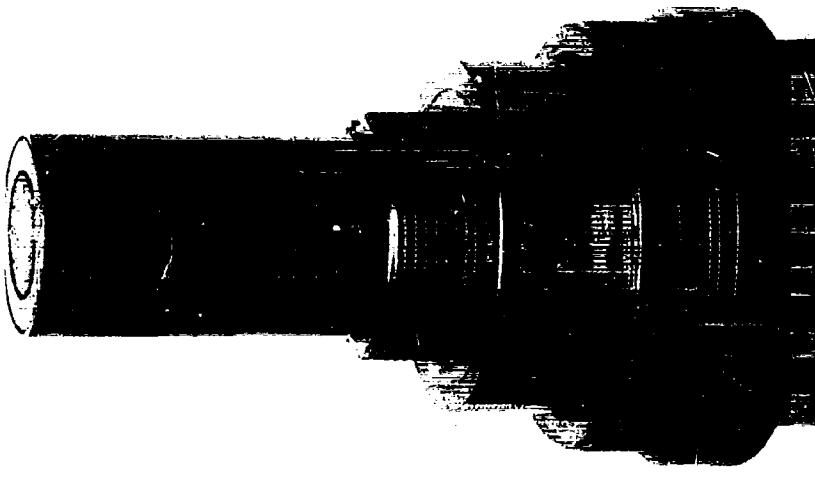
For more information about the study, please contact Dr. Michael J. Hwang at (319) 356-4530 or via email at [mhwang@uiowa.edu](mailto:mhwang@uiowa.edu).

10. The following table shows the number of hours worked by each employee in a company.

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**APPENDIX C**





Report No. 4P9-70573 - 250 11.3. p. Low Drag Form UX 91 and 11, High Velocity Impact Tests.  
Item: Fuzee developed by Alliant Technical Services Company for pulsed Missile Warhead.

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**LUKE'S STEEL COMPANY**

BANISTER P. 63 250 C. 45 200  
ST. FIG. 1. - 50. 51-1700, 400  
FIG. 2. 1. 1000, 1000

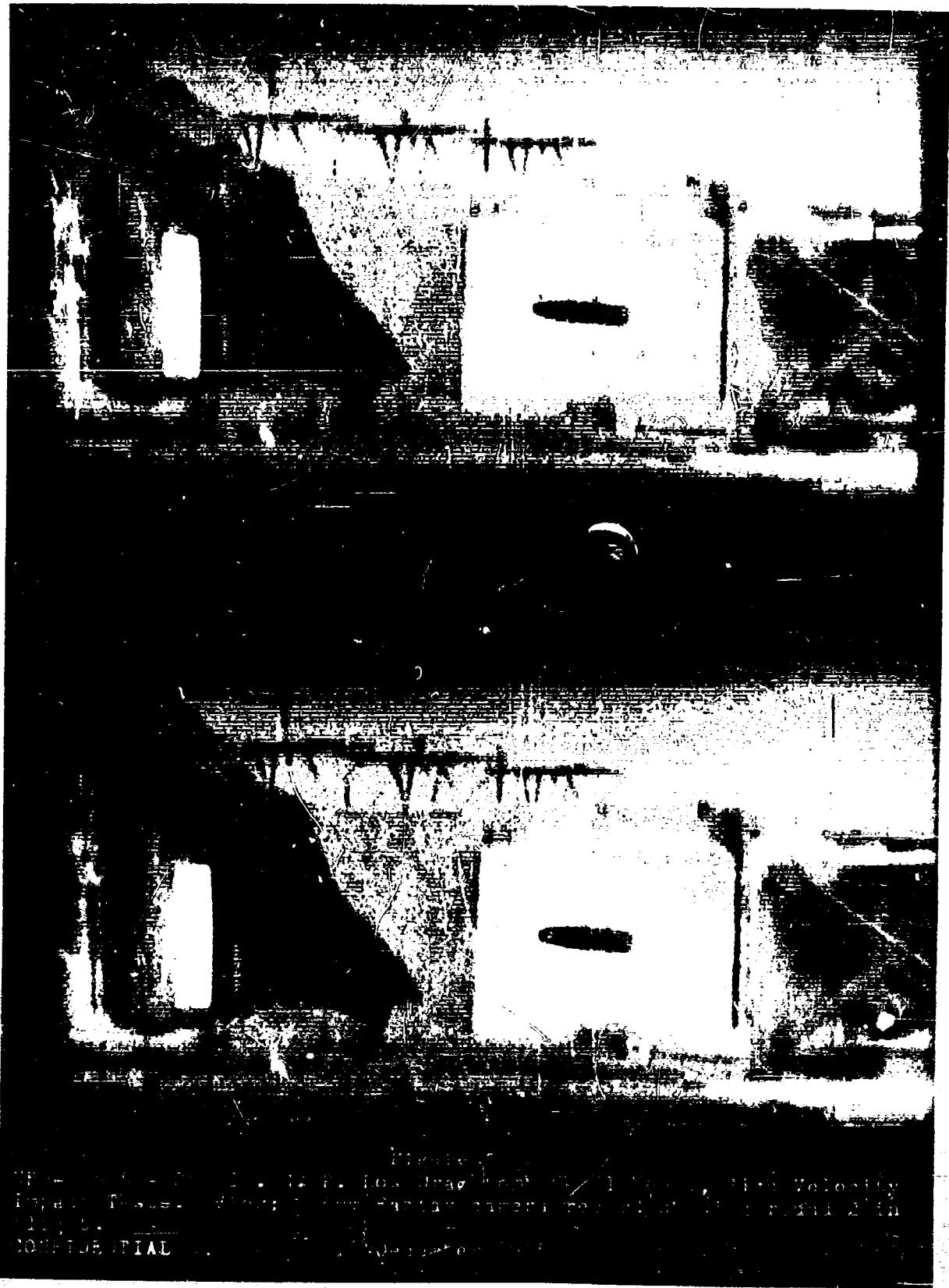
198 - 199



NP9-70574 - 250 lb. 7.5 in. diameter bomb				High Velocity Impact Test	
Impact No.	Date	Project No.	Agent	Location	Penetrating Power
43477	12/16/55	2	Sand	21 • 1/2 in. Comp.	Penetrated
Remarks: Inert explosive forward section of bomb broke up, base held together.					

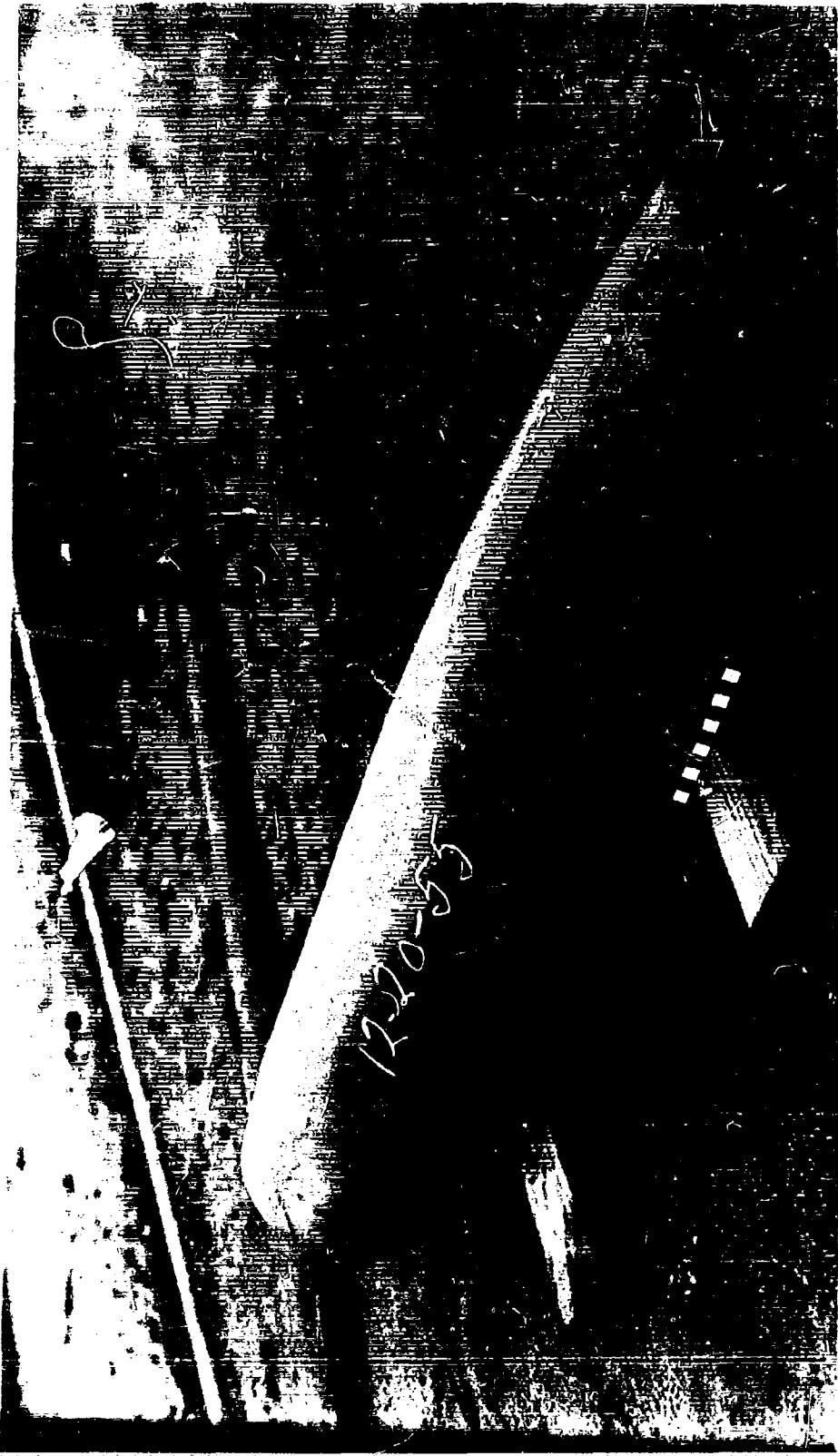
December 1955

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Impact of a 14.5 mm. bullet at 1,000 ft. per second on a 1/2 in. thick steel plate. Two 16 mm. Panavision cameras recorded the impact in sequence.

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K 3493  
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#### REFERENCES

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**APPENDIX D**

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<p>Naval Proving Ground. NPG Report No. 1449 HIGH VELOCITY IMPACTS OF 250 LB. G. P. BOMB MK 81, By F. W. Kasdorff. 29 Mar 1956. 5 p. 6 tables, 9 figs. CONFIDENTIAL</p> <p>Inasmuch as the impact velocity of the 250-lb. G. P. bomb Mk 81 is expected to fall in the range of 1100 to 1900 ft./sec. the question has arisen as to whether the bomb's ability to penetrate targets in effective bursting conditions will be seriously impaired by the high striking velocities. Results indicate that it will:</p> <ul style="list-style-type: none"> <li>(a) Penetrate 7/8" STS armor plate at 20° obliquity at 1470 ft./sec. but will break up in penetrating this target at 1735 ft./sec. or higher velocities.</li> <li>(b) Penetrate sand or normal earth (free of rocks, stones, etc.) and remain in effective condition at 1700 ft./sec. and 20° obliquity but will break up at 1900 ft./sec.</li> </ul>	<p>I. General purpose bombs - Terminal ballistics CONFIDENTIAL</p> <p>II. Title III. NPG-S3-3d-442-1-56</p>	<p>I. General purpose bombs - Terminal ballistics CONFIDENTIAL</p> <p>II. Title III. NPG-S3-3d-442-1-56</p> <p>Inasmuch as the impact velocity of the 250-lb. G. P. bomb Mk 81 is expected to fall in the range of 1100 to 1900 ft./sec. the question has arisen as to whether the bomb's ability to penetrate targets in effective bursting conditions will be seriously impaired by the high striking velocities. Results indicate that it will:</p> <ul style="list-style-type: none"> <li>(a) Penetrate 7/8" STS armor plate at 20° obliquity at 1470 ft./sec. but will break up in penetrating this target at 1735 ft./sec. or higher velocities.</li> <li>(b) Penetrate sand or normal earth (free of rocks, stones, etc.) and remain in effective condition at 1700 ft./sec. and 20° obliquity but will break up at 1900 ft./sec.</li> </ul>
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